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PLANT PROTECTION OVERSEAS REVIEW

A PERIODICAL SURVEY OF NEW DEVELOPMENTS IN THE CONTROL OF PESTS, DISEASES AND WEEDS

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CONTENTS

EDITORIAL

SOUTH, East and West Africa, the Colony of Mauritius and the warmer regions of Asia and America are the overseas territories forming the background to some of the agricultural problems discussed in this number.

Important pests prevalent in these countries and means for their control are discussed by writers with long and wide local experience of the problems involved, who are recognised authorities on their respective subjects.

One of these articles is devoted to the study of human and cattle pests as well as those attacking crops. Nevertheless we welcome it in the *Overseas Review* on account of its general interest and the very great injurious effects indirectly exerted on crop production by the prevalence of pests attacking man and his livestock.

We include also a further article on up-to-date weedkilling methods, reprinted from the magazine *Farming*, by kind permission of the Editor of that paper, and a second article in the series on chemical seed-dressings, in both of which subjects there are frequently occurring fresh developments and which are of world wide agricultural interest and importance.

PRE-EMERGENCE WEED KILLER POSSIBILITIES

by E. HOLMES, Ph.D., M.Sc., F.R.I.C.
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(*Reproduction of an article appearing in "Farming," October*, 1950, *by kind permission of the Editor.*)

THE production of agricultural crops has always involved the problem of how best to enable the crop plant to make maximum use, and the weeds minimum use, of soil moisture and plant food. In the spacious days of half a century and more ago, when labour was plentiful and wages low, hand pulling and hoeing of weeds were major farm operations taking up much more time than the farmer can afford today. But weeds are still with us and still require suppression.

It is not surprising, therefore, that chemical weed control has made great strides in the last half-century. Starting with the use of dilute copper sulphate solutions, kainit and cyanamide dusts, the development of selective weed killers moved on to dilute sulphuric acid and then to different formulations of di-nitro-ortho-cresol (DNOC or DNC) in the 'thirties. All of these were used almost exclusively for control of broad-leaved weeds growing in cereals. All worked by means of a selective scorching action based on the differences in physical retention of the dusts or sprays on the often flat and sometimes hairy leaves of the weeds such as the charlocks, and on the vertical, shiny leaves of the cereals.

In many respects the most fundamental advance came in 1940 when Dr. Templeman of the Jealott's Hill Agricultural Research Station discovered the first of the plant-growth regulator, selective weed killers. These are exemplified by the now well-known 2,methyl-4, chloro-phenoxyacetic acid (MCPA) and the corresponding 2,4-dichloro- chemical (DCPA or 2,4-D).

It should be made clear that all of these so-called 'selective' weed killers are only relatively selective. All plants vary in their susceptibility or resistance to all chemicals. For example, sodium arsenate or sodium chlorate are usually regarded as general weed killers; that is, they will kill all types of vegetation. This is perfectly true provided a sufficiently high rate of application is given. But both will act as selective weed killers if only small dosages are given. Conversely, the best of the newer 'hormone' selective weed killers will act as general weed killers

if used in sufficient amounts. The most successful selective weed killer is obviously the one with the biggest margin between the amount that kills the largest number of deleterious weeds and the amount that just begins to damage the crop.

In the past ten years there have been tremendous advances. The first five years represented the necessary period of chemical and biological work—mainly secret because of war-time conditions. The second five years have seen the acreage treated commercially rise into the millions in a number of countries of the world. But despite the practical success of the early ones, the scientists have continued to work on new compounds and new methods of application. Which brings us to the consideration of what has now come to be called 'pre-emergence' weed control.

PRE-EMERGENCE WEED KILLING

It should be made clear that the term 'pre-emergence' refers to the crop; not the weeds. In other words, the weed killer is applied either before the sowing of the crop or after sowing but before the crop emerges. It is, of course, true that such application is usually, but not necessarily, pre-emergence in relation to the weeds.

Both MCPA and 2,4-D will act as efficient pre-emergence weed killers against certain species of weeds; even grassy weeds, if the applications are heavy enough. Templeman early showed that MCPA was an efficient pre-emergence killer of charlock, but for practical reasons the best time of application is usually much later, when the cereal crop is, say, four to six inches high.

The most important commercial development of this idea so far has been the use of these chemicals against germinating weeds in sugar cane and maize fields. The usual rate of application has been 2 to 5 lb. per acre, 3 lb. being the most consistently successful on a cost and efficiency basis.

Not only do such applications control the broad-leaved weeds usually regarded as most susceptible but such species as Johnson grass (*Sorghum halepense*), crab grass (*Digitaria* spp.), panic grass (*Panicum* spp.), Bermuda grass (*Cynodon dactylon*) and so on. A few grasses such as the foxtails (*Setaria* spp.) and sandburs (*Onchrus* spp.) are rather more resistant and may not be killed even by the higher rates of application.

Weather conditions and soil type have a profound effect on the efficiency of such treatments and on possible damage to the crop plants. Heavy rainfall after treatment may wash the chemical away before it can exert its effects; light rains during the period of activity, normally six to eight weeks, are beneficial. The risk of serious leaching is obviously greater in sandy or gravelly soils deficient in organic matter, and least in heavy clay soils.

There appears to be little difference in efficiency between the sodium salts, amine salts or esters of these compounds but when heavy leaching is feared the esters in petroleum oil are most persistent.

Until recently results with other crops have been inconclusive or not very encouraging. In fact, such applications are not officially recommended in North America except on maize. Other cereals may be seriously damaged, oats being most and barley least sensitive.

It may be mentioned, however, that some good results have been obtained in the pre-emergence treatment of potato land. On the other hand small applications to sugar beet delayed emergence of the crop, were not very successful against the grassy weeds and resulted in some misshapen beet. Onions grown from seed have been seriously damaged on poorly drained, light soils, but have been little affected on well-drained, peaty soils.

Before turning to the latest and very promising British work in this direction it will be advisable to consider that other very interesting selective weed killer, isopropyl-phenyl-carbamate.

IPPC

In discussing isopropyl-phenyl-carbamate (IPPC) I should make it clear at the outset that this chemical is not yet available in Britain at prices which make it of practical interest to the farmer.

IPPC is popularly regarded as the complement of MCPA or 2,4-D. Whereas the latter are toxic in general to the broad-leaved plants, the former kills many of the monocotyledonous plants, the grasses in particular. This distinction is by no means clear cut. For example, MCPA and 2,4-D are, as we have already seen, effective against many grasses in the germinating and seedling stages, and IPPC is toxic to such a typical dicotyledonous plant as chickweed (*Stellaria media*). It seems possible, however, that IPPC will become a practicable product for controlling germinating annual grasses and volunteer cereals in resistant crop species, which include many important roots and legumes.

As with the earlier hormone weed killers, the initial discovery of IPPC as a weed killer and the first work on it were due to Dr. Templeman at Jealott's Hill, working in association with Dr. Sexton of Manchester. Since then, however, a great deal of work has been undertaken on the subject in America, France, Sweden and Russia.

The responses of plants to IPPC are quite different from those induced by the phenoxy-acetic acid types of growth-regulating compound. IPPC causes no bending or epinastic effects. It has a marked effect on the meristematic tissues, inhibiting cell division with an accompanying increase in chromosome numbers and a great enlargement and maturation of these cells. Like other plant-growth regulators IPPC prevents tissue respiration.

Present experience suggests that IPPC is mainly effective when used as a soil treatment against germinating or seedling grasses. It should be applied as a pre-emergence soil treatment, or as a carefully timed early post-emergence application at the time the grasses normally germinate.

U.S. and Canadian experience suggests that IPPC works best in warm, damp soils. In dry soils in cold weather in Canada results have been disappointing. IPPC is relatively rapidly broken down in the soil by the action of micro-organisms, and normal dosages persist for only a few weeks.

WEEDS AFFECTED BY IPPC

Much work has been done in the U.S. against quack grass (*Agropyron repens*). Applied at the rate of 2 or 3 lb. to 8 or 10 lb. per acre in the germinating or seedling stages almost complete control has been obtained, this work having been confirmed in Sweden. On the other hand, established quack grass appears resistant to dosages as high as 200 lb. per acre.

Wild oats (*Avena fatua*) seem almost as susceptible. Laboratory experiments have shown excellent kills with soil applications of 5 lb. per acre, whilst in the field 5½ lb. gave a control of 60% to 95%, and 9 lb. almost complete control.

Crab grass (*Digitaria* spp.) has been almost completely prevented from germinating with pre-emergence applications of as little as 2 lb. of IPPC per acre. Again established stands of the grass were completely resistant. Foxtails (*Setaria* spp.) responded similarly. On the other hand, nut grass (*Cyperus rotundus*), Bermuda grass (*Cynodon dactylon*) and Johnson grass (*Sorghum halepense*) seem to be quite resistant to ordinary dosages.

As already mentioned, chickweed (*Stellaria media*) is particularly susceptible. Applications of 5 lb. of IPPC per acre suppressed growth during a period of three weeks. Conversely it did not give a kill of chickweed that had already emerged in the autumn.

Doubtless many other weeds will prove particularly susceptible or resistant, but much more work is in progress or is required.

As would be expected, germinating cereals are very susceptible to as little as 2 lb. per acre of IPPC. Flax and buckwheat are almost as sensitive, whilst potatoes, tomatoes, eggplants, peppers, cucurbits and tobacco were also damaged at low rates of application.

Tolerant crops include beet and sugar beet, broccoli, cabbage, turnip and radish, lucerne, clover, ground-nuts, peas and beans, soya beans, hairy vetch, cowpeas and other legumes, parsley, carrot and parsnip, lettuce, onions, strawberries, cotton and sunflowers. The possibilities of valuable selective effects are obvious.

A little earlier this year Dr. Templeman and his co-worker, Mr. Wright, gave a preliminary account (*Nature*, 1950, **165**, 570-1) of some most interesting results obtained during 1948 and 1949. The trials were "aimed at replacing costly cultivations in root crops by chemical methods of weed control," and were based on the differential responses of different weeds to MCPA and 2,4-D on the one hand and to IPPC on the other.

The first two compounds were used at 1 to 2 lb. per acre and the third at 2½ and 5 lb. per acre, and the single and mixed applications were made up to 8 weeks before the sowing of the crop. The chief experiments were made on kale and mangolds, but lettuce, onions, field beans, peas, lucerne, sugar beet and swedes were included in 1949.

The results may be summarised as follows :

1. IPPC alone at both rates gave good control of grasses and *Polygonum* spp.
2. MCPA and 2,4-D prevented the emergence of the usual wide range of susceptible weeds.
3. Mixtures of 5 lb. per acre of IPPC and 1 lb. per acre of MCPA or 2,4-D gave excellent control of both sets of weeds, whilst against chickweed (*Stellaria media*) and cleavers (*Galium aparine*) the mixture was better than either component alone.
4. The weed killers were more effective when applied before emergence of the weed seedlings and when there was least subsequent disturbance of the soil.
5. 5 lb. per acre of IPPC applied as late as two weeks before sowing had no adverse effect on kale, mangolds, lettuce, onions, beans, peas, lucerne, sugar beet and swedes.
6. The minimum safe period between application of MCPA or 2,4-D at 1 lb. per acre and sowing was three to four weeks, heavier dosages requiring longer, and
7. Mixtures as under 5 and 6 above gave similar results on the crops.

Although it is made very clear that these experiments were preliminary and the conclusions only tentative, the results obviously open up the possibilities of extended uses of these weed killers in new and potentially very important directions.

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THE FIGHT AGAINST SOME IMPORTANT INSECT PESTS IN SOUTH AFRICA

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SOUTH AFRICA has one of the richest flora in the world. The fauna too is famous and the larger types have brought joy to many who have seen them in our National Parks. But these gifts of Nature are not without their disadvantages from the human viewpoint and, where Man and Nature meet on the subcontinent, insects and disease are two of the many ugly things that hide so often behind its fair mask. In this article an attempt will be made to bring to the notice of readers in other parts of the world some of the problems encountered in South Africa by an economic entomologist. They are problems which concern man himself, his cattle and his crops.

THEY LIVE IN HUTS

Huts are well known to all South Africans, and picturesque groups of them in the hills, surrounded by our native life, have brought exclamations of delight from many visitors. But how many of us know the relationship that exists between insects, man and those huts? It was a question I had often asked myself, but for lack of a ready method, it was never studied. At times I had contemplated covering a hut with a gas-tight canvas tent, fumigating it with HCN, and collecting all insects knocked down. This was never done because of the trouble and danger involved, and an answer to the question had to await the arrival of BHC.

This insecticide is toxic to many insects and has a persistent action. It is easily applied in the form of toxic smoke which is ideal for treating mud plastered thatched huts. Co-operators were readily found in the heart of a native reserve in the Eastern Cape Province. Here, away from the beaten track, as the mists encircled the hills and descended upon us, four, out of a cluster or " Umzi " of nine huts, were treated with BHC smoke generators. Early each morning for six consecutive days after treatment, the huts were carefully swept, and the sweepings placed in jars containing formalin. At the end of this period we had 24 jars, six from each hut, and each jar contained a mass of dead insects mixed with other debris.

Fig. 1.—Huts in the hills in Keiskama Hoek, Eastern Cape Province. Four of these were treated with BHC smoke generators.

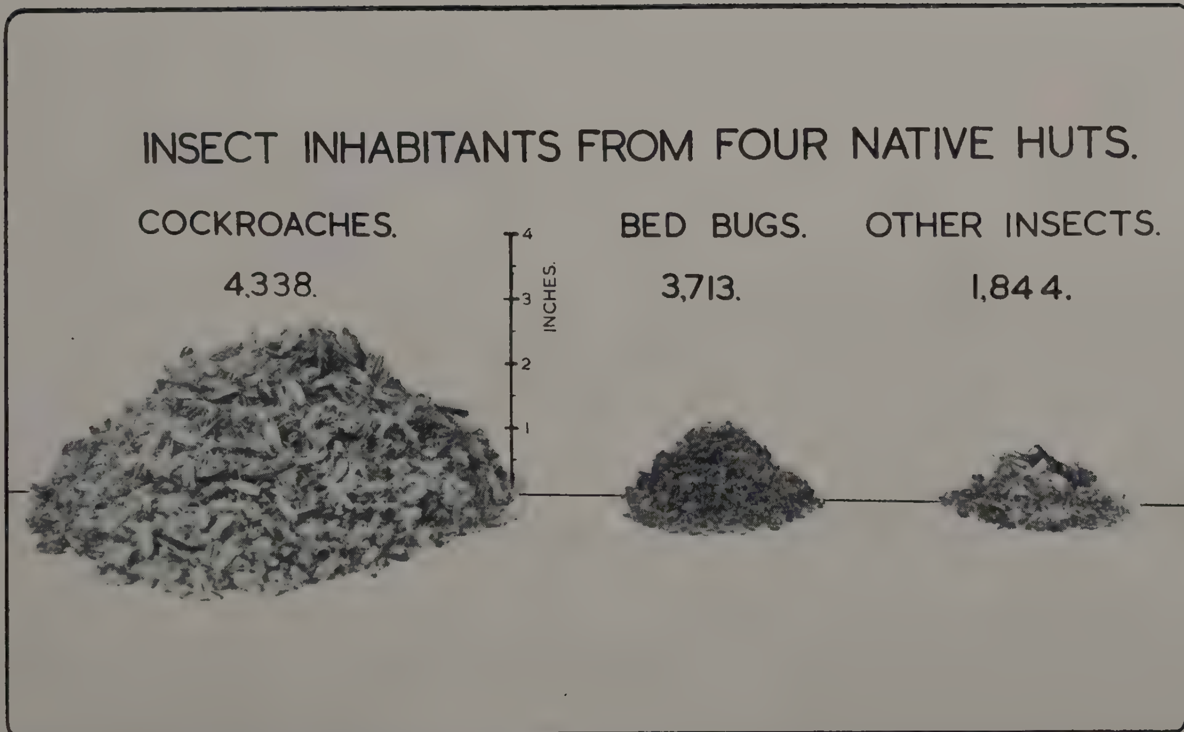

Fig. 2.—What came out of the huts! After treatment the huts were carefully swept for six consecutive days. Later the insects collected in the sweepings were sorted, classified and counted.

Fig. 3.—" The Old." Taking flies for dissection from a " Harris " Fly trap. The traps caught millions of tsetses in the Umfolosi Game Reserve, Zululand, during 1931 and subsequent years.

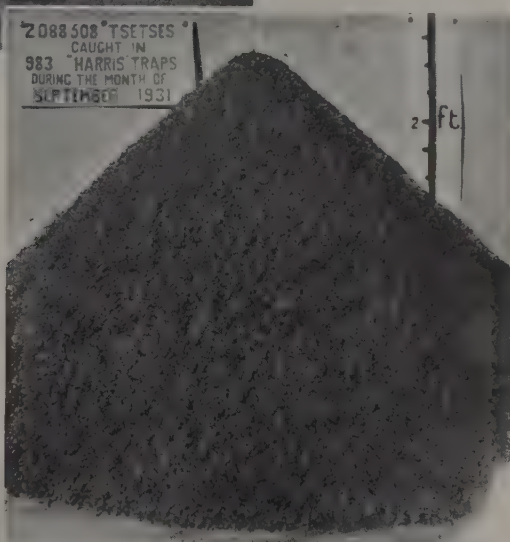

Fig. 4.—The " catch " for one month in 1931.

Fig. 5.—" The New." A helicopter applies toxic BHC smoke to fly country in the Hluhluwe Reserve, Zululand, August 1950. There are no visible results as with " The Old," but traps, together with bait animals, are still used for fly surveys. The absence of fly indicates the success of the method.

Fig. 6.—A typical citrus fumigation scene in South Africa. Fundamentally it is the same here as in other citrus growing areas of the world. There are, however, South African characteristics, the main being the large numbers of natives employed in a fumigation gang.

Fig. 7.—Sprays ; oil, parathion or combinations of these, applied by bigger and better machines, are gaining popularity as scale control measures.

The task of sorting this material and counting the insects was tedious, but the technique improved as experience was gained. During the six days nearly 10,000 insects were collected from the four huts, an average of about 2,500 per hut. Of the 10,000 insects nearly half were German cockroaches, one third were bed bugs, the remainder being miscellaneous insects represented by some 30 varieties. This is a fair representation of the insect life, which would be found in similar circumstances in any four native huts in a rural area. The parts played in other African territories by mosquitoes and Argasid ticks as transmitters of disease among native inhabitants of huts, are well known and have been discussed in numerous scientific papers. The startling relationship between huts, men and insects described above, was not well known. It doubtless applies to the 6¼ million rural natives in South Africa. Such conditions lead to inefficiency due to restless nights, and to waste, when insects take their feeds in the form of human blood and human food. The pests should no longer be regarded as necessary evils, for they can be controlled by the new insecticides in a manner that is safe and easy to apply.

TSETSE FLIES

There is always a thrill in visiting old haunts, for the memory harks back and plays pleasant pranks with one. I had this experience recently, and, as it concerns entomology, it would not be out of place to record some of those impressions here. We all have memories of our first jobs, and mine go back to Zululand. I arrived there in 1931, ready to contribute my little share to the study of the tsetse problem; that scourge of the African continent. In Zululand, which could be such a wonderful cattle country, fly disease or nagana had proved a stumbling block to farmers and many a homestead stood deserted. The fly had separated man from his domestic animals. At that time the trapping campaign against the tsetse was in full swing, and I was detailed to determine what percentage of flies caught were infected with trypanosomes. This entailed the careful dissection of many thousands of tsetses, for it was essential that, in each, the proboscis, salivary glands and gut should be examined. I well remember many visits into the Umfolosi Game Reserve, and how I took many thousands of tsetses (*Glossina pallidipes*) from the Harris Fly Traps. I remember the game animals that abounded in the reserve; the huge, yet surprisingly nimble white rhinoceros, the herds of buffalo, the wildebeeste and zebra, the stately koodoo, the warthogs and the smaller bucks. I remember the thrill of seeing my first living trypanosomes under the microscope and, I remember, how in December 1931, I found for the first time in Zululand, a *T. brucei* infection of the salivary glands of *G. pallidipees*. It was an important discovery, but that is another story.

This work on tsetse flies was fascinating, and it was indeed striking to note how the trapping campaign appeared to be reducing the numbers of flies. In September 1931, 983 traps caught over two

million flies, and in November 1931, 1,093 traps caught less than half a million. In 1931 it was easy to collect flies from traps but by 1933 it was difficult to obtain them for dissection purposes. It really did seem that the traps were having an influence upon the fly population and, with continued action by more and more traps, the tsetse, *G. pallidipes*, would be beaten. Those were the impressions that prevailed in 1933, and it was with those that I left Zululand that year, and did not visit it again until August 1950, 17 years later.

The campaign against the tsetse was continued and intensified, and by 1940 thousands of traps were spread over the three Zululand Game Reserves, Umfolosi, Hluhluwe and Mkuzi. For a while the flies decreased in numbers, but from 1941 onwards they started to increase. It is not known exactly why, but it is worthy of note to record that, owing to war conditions, the traps were allowed to deteriorate and could not be recovered with hessian. The build-up in fly population in 1942 and onwards may be connected with this neglect.

An internecine campaign among *Homo sapiens* eclipsed that of man against the tsetse and, when the fight against the fly was resumed, the trap was a thing of the past. Studies on the habits and distribution of the fly continued, the most important being the pupal casing surveys. Pupal cases do not disintegrate readily, and last a long time in the litter of a breeding area, so over the years many will accumulate. The campaign which was to follow was largely dependent upon these surveys, which pin-pointed the breeding areas. It was upon these that the campaign was waged, leaving the dispersion areas to take care of themselves. Game destruction played a part as it did in 1931 when 33,000 head were shot in Umfolosi, and some 70,000 were killed in 1941. Now the white rhinoceros reigns alone in Umfolosi. Later experience showed that this slaughter was not necessary, but the right way is only found after the wrong has been tried. Bush clearing has also played its part.

Thus the vast changes I noticed after 17 years were the abandonment of traps, the sad absence of game in Umfolosi and large areas cleared of bush. Traps have been replaced by chemical control measures. The new insecticides, DDT and BHC, applied by aircraft, Ansons and helicopters, have formed the main feature of the present campaign. A 30% solution of BHC in toluene and dieseline is used through the exhaust of the aircraft, and the smoke produced envelops the vegetation, particularly that of areas indicated by the pupal survey. In places where aircraft cannot operate safely, the insecticides are applied from the ground as smokes from small generators or as dusts from power driven or hand machines. Bush clearing has been used to confine the fly for a more concentrated attack. It seems that the toxic smoke has sealed the fate of *G. pallidipes*. None of this species of tsetse has been caught in traps or on bait animals at Mkuzi for two years. None were caught at Umfolosi during May and June 1950, but in July two flies were caught in traps, while bait animals drew a

blank. The hilly Hluhluwe reserve, with its delightful tourist camp and plenty of game, presents a different problem. It is here that helicopters play their fascinating part. Tsetses, G. *pallidipes* and G. *brevipalpis*, are still being caught at Hluhluwe in both traps and on bait animals and, where they are caught there, the deadly smoke screen is laid. Helicopters hover a few feet above the tree tops. The Zulus aptly liken them to dragon flies, making crude reference to the peculiar habit they have of touching water with the tip of the abdomen.

Since 1941 the South African Government has spent about £1,000,000 on its tsetse campaign, and it is likely that a like amount was spent before that date on the trapping campaign. The tsetse is still not eradicated and the obscure G. *austeni*, a small fly in which we were little interested in 1931, may well prove " the fly in the ointment." It is widely and sparsely distributed in Northern Zululand, and has been taken from the neighbouring territories of Swaziland and Portuguese East Africa. It is caught regularly in traps during fly surveys in Swaziland. Thus the obsolete trap is still used to determine the presence of fly, and it is significant that it sometimes catches where bait animals fail. It was, however, ironical to see hundreds of traps lying about in piles in the reserves, while others were used for making huts ; so different from the times when I regularly visited well cared-for traps to collect my flies for dissection purposes.

SCALE INSECTS AND CITRUS

No agricultural activity is without its biological problems, and in South Africa they are many and varied. Insect pests are a menace, some crops being more susceptible than others. Of the main crops grown in the Union, Maize, Wheat, Sugar, Citrus Fruits, Deciduous Fruits and Wattle, it seems that Citrus is most prone to insect attack. Scale insects, false codling moth, thrips, fruit flies, and mealy bugs, are some of the insects which cause much damage in citrus orchards. Pride of place, if such a phrase can be used for an insect pest, must go to the scale insects, and among them the red scale, *Aonidiella aurantii*, is, without doubt, the most important economically. These little insects infest all parts of the tree—fruit, leaves, branches and trunk. They may cause heavy defoliation ; branches of considerable size may be severely injured in a single season's infestation ; and infested fruits are unmarketable. The scale insects have remarkable powers of reproduction and it is doubtful whether they could ever be eliminated. They have a fascinating and complicated association with parasites and predators, but, as I have said above about the tsetse and its trypanosomes, " that is another story."

Red scale on citrus can be controlled by regular methods, of which two are generally recognised :— (1) fumigation with HCN gas and (2) spraying with oil sprays. Recent developments suggest that these methods may be superseded by the phosphorous insecticides, particularly Parathion, but there is still much to learn about this insecticide.

Fumigation, which consists of covering trees with cloth tents and liberating HCN gas beneath these, has had the same chequered history in South Africa as in other citrus growing areas of the world. The "pot method" was followed by the "cyanofumer", in both of which sodium cyanide and sulphuric acid were used to generate the HCN gas. "Ex Africa semper aliquid novi", can truly be said of plant fumigation. In spite of R. S. Woglum's intriguing story in the "California Citrograph", Vol. 35, p. 69, where he claims that Liquid HCN was discovered (what about Scheele, 1782?) in America as a result of an accident and alertness on the part of William Dingle in 1916, South Africa can stake a prior claim! In 1915 C. W. Mally published a paper entitled, "Anhydrous Liquid Hydrocyanic Acid for Fumigation Purposes", in the South African Journal of Science, Vol. XII, pp. 95—96. It was this paper which revolutionised fumigation procedure, for Mally had used Liquid HCN as far back as 1914 to control mealybugs on grape vines! Woglum and our American friends do have some claim; Mally was an American by birth, but the Liquid HCN idea came "ex Africa."

Liquid HCN in glass ampoules, HCN absorbed in kieselguhr, calcium cyanides, and Liquid HCN applied by atomising machines, have all played their part as control measures for red scale. They have held the insect in check and allowed the industry to develop. In only one of our eight major citrus producing areas, namely Kat River, Fort Beaufort, C.P., did we encounter HCN-resistant scale. This was brought under control by oil sprays and some biological factors which are not fully understood.

Recently the popularity of fumigation has waned owing to the increased costs of canvas and the disagreeable nature of the night work. Oil sprays, applied by bigger and better machines, have come to the fore. Parathion, alone or in combination with oil, is gaining favour, but it is still largely an unknown quantity. Field trials with systemic insecticides have not been encouraging. The ideal insecticide for the destruction of red scale, pest No. 1. of the Citrus Industry, has still to be found.

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STEM BORERS OF CEREALS AND SUGAR CANE

By W. F. JEPSON, Ph.D., B.Sc.

INTRODUCTION

STEM borers of Graminaceous crops are, for the most part Lepidopterous caterpillars, although Dipterous and Hymenopterous larvae also occur as major pests. Examples from the temperate regions are the European Corn Borer (*Pyrausta nubilalis* Hbn.) of the U.S.A. and Canada ; the Frit fly of oats (*Oscinella frit* L.) in Europe, and the Wheat Stem Sawfly (*Cephus cinctus* Norton) in Canada.

In this article, we shall attempt to draw attention to the importance of the Lepidopterous stem borers of the cereals and sugar cane grown in the warmer regions of Asia, Africa and America, and to suggest that the essential unity of the many problems involved demands a common approach.

In general, the crops concerned are maize, the sorghums and millets, rice, and sugar cane, and the pests are Pyralid moths of the genera *Diatraea*, *Proceras*, *Chilo* and *Schoenobius*, and Noctuid moths of the genera *Sesamia* and *Busseola*.

If one may judge by the frequency of published reports and investigations on this group as well as from many years of experience in tropical entomology, it may be confidently stated that, as a world problem, stem borers are at least commensurate with locusts. The fact that their attack is insidious, their incidence flaring up locally in time and space, divides and rules us in our attitude to the pests and to our method of approach to control. The writer is preparing for publication a critical review of the literature in order to see if some common ground cannot be found upon which concerted lines of attack can be formulated.

NATURE AND EXTENT OF LOSSES CAUSED BY STEM BORERS

The moths themselves do no damage, but are nocturnal, laying their eggs on the plants from very early growth stages almost to maturity. The young larvae bore into the stems, where they feed during the whole of their development, causing damage typical of the particular state of growth of the host plant. In young plants of sugar cane or maize for example, the central shoot may be killed, and

a brown " deadheart " result ; in rice, yellowing and death of the young seedlings or transplants may take place in typical patches (straw hat damage). In older, maturing plants, some species cause such weakening of the stem that wind breakage readily occurs, and when, as the writer has seen in Western Tanganyika, caterpillars of *Busseola fusca* become very numerous, almost every internode is occupied, and the plant fails to produce a flowering head. In sugar cane, caterpillars of *Proceras* and *Diatraea* eat sufficient tissue to cause a serious degree of inversion of the sucrose, as well as paving the way for the ingress of pathogenes such as the red rot fungus, *Colletotrichum*.

The estimation of loss is accompanied by so many pitfalls that exaggerated accounts, so frequent in the literature, have too often been discounted by those responsible for taking counter action against pests. Figures of 25,50 and even 75 per cent. of " deadhearts " in young plantations, and of up to 80 per cent. of mature plants attacked by borers are often quoted, leaving the reader with the idea that this represents a loss of crop of these amounts. In fact, in many areas, as in rice in Formosa, rapid tillering completely nullifies a heavy destruction of primary shoots by borers. In Africa however, a short critical growing season may fail to make up the time lost by the plant, especially maize, in putting forth new tillers. Apart therefore from individual fields which fail completely, the entomologist must be most conservative in attributing to stem borers more than a fair share of responsibility for loss of crop. It may be legitimate to point out that the borer *Sesamia calamistis* prevents the cultivation of a second crop of maize in Ashanti, or that famine has been caused in Kyushu (Japan) by *Schoenobius* in the rice crop. There is no doubt however, that global losses of grain or sugar in most countries should be expressed in single figures, and that 2 to 5 per cent. preventable loss by borers should be admitted and accepted as a serious challenge to the agricultural scientist. It in no way minimises the necessity for action to associate this loss factor with others more familiar to the agriculturalist such as overseeding with poor varieties, lack of weeding, singling, manuring, each of which, if they could be universally remedied, would go far towards meeting food shortages.

LIFE HISTORIES OF SOME STEM BORERS

BUSSEOLA FUSCA Fuller. (Noctuidae). The African Maize Stalk Borer.

This species is widely distributed between South Africa and Uganda, being most destructive to maize and millets in the drier parts of the African Savannah. The moth lays its eggs on any part of the plant, but preferably in the region of the bases of leaf sheaths, where groups of over 100 eggs are commonly found. The young larvae wander over the leaf blades, taking their first meal from the epidermis, which is scarified. Very soon, the larvae bore into the shoot through the curled top leaves, which, on expansion show

typical bands of ragged holes. In young plants the larvae bore downwards, and may enter two or three internodes during their development. After 30—50 days, the waxy white larva pupates within the lárval tunnel. In tropical areas the moth emerges 10—14 days later, but in South Africa the pupa hibernates in the maize stubble. There appears to be no diapause in the warmer areas, and the borer must therefore find alternate hosts during the long dry season. The writer has found *Busseola* in *Panicum maximum* (Guinea grass) and *Pennisetum purpureum* (Elephant grass) in Tanganyika, and doubtless there are many more hosts amongst the larger grasses, but there is an urgent need for properly planned ecological work in this field.

Maize may be attacked by two generations of *Busseola* during its development, the caterpillars of the second generation may infest a high proportion of the internodes, and are commonly found boring into the cob. In dry marginal areas the plant is unable to withstand the wilting caused by loss of tissue, but if growth is proceeding rapidly in a good season, the effect on the crop is negligible.

SESAMIA SPP. (Noctuidae). The Pink and Violet Borers.

In West Africa, the place of *Busseola* is taken by another Noctuid, *Sesamia calamistis* Hmps. This species has recently been investigated by Mr. J. Bowden in the Gold Coast, who has drawn attention to the chaotic state of the systematics of the Old World stem borers, and who is now engaged on a revision of the genus *Sesamia*. In the Eastern Province and Ashanti, early planted maize may show 80 to 100 per cent. attack, and a second crop cannot be attempted, although the climate would allow it. In the Northern Territory, *Sesamia* may cause the complete failure of the late millet crop.

In the Sudan, *Sesamia cretica* is a major pest of millet, and throughout Asia, *Sesamia inferens* is constantly reported as attacking maize, millet, rice and sugar cane. In Mauritius, *Sesamia vuteria* is the Pink Borer of sugar cane, and the same species (?) is a serious pest of maize and wheat in Morocco.

Sesamia inserts its eggs between the leaf sheath and the stem, so that the larvae are scarcely exposed on the plant at any stage. The larvae, which can survive for long periods of submergence in paddy fields, spin a silken web beneath the leaf sheaths in which pupation takes place.

An interesting feature of the *Sesamias* is their wide range of alternate hosts. In Formosa, the generation on rice is followed by one on sugar cane, but in general wild grasses form the natural reservoir of infestation, and the investigations instituted by Bowden in the Gold Coast should pave the way to a more systematic approach to this important aspect of the borer problem.

DIATRAEA SPP. (Pyralidae). The Small Moth Borers of the New World.

For the purposes of the present article, we shall refer all the Old World Pyralids to the genus *Proceras*, although they will be found in all the older literature under *Diatraea*.

Diatraea saccharalis F., the sugar cane moth borer, is the most universal pest of this crop from Louisiana to the Argentine, demanding unremitting efforts on the part of the scientific Departments to improve existing methods of control. In the West Indies, the moth borer is an important factor in Cuba, Puerto Rico, Antigua, St. Kitts, St. Lucia and Barbados. The allied species *Diatraea lineolata* is the maize borer of Trinidad.

The eggs of *Diatraea* are laid in imbricated rows usually in groups of 30 to 100 on the under surface of the leaves. The young larvae on hatching feed on the epidermis for the first day or two. They then bore into the stem, quickly causing the heart to wilt and die, so that the "deadheart" is an early and typical symptom of an attacked canefield. Generations follow each other in summer every 45 to 50 days, and since sugar cane is commonly grown as a perennial crop for 5 or more ratoons, large populations of moths are constantly maintained, locally controlled only by weather and by parasites, which are numerous and important.

PROCERAS SPP. (Pyralidae). Spotted borers of the Old World.

Formerly known under the names *Diatraea* and *Argyria*, these borers have a wide host range. *Proceras argyrolepida* replaces *Busseola fusca* as the maize borer of the East African coastal regions (Harris, 1946). In Mauritius *P. sacchariphagus* Bojer., (*Diatraea mauriciella* Wlk.), is a major pest of sugar cane, and some of the newer cane varieties are particularly susceptible. The corresponding species in India is *P. sticticraspis H*, which Dr. Singh Pruthi considers to be one of the worst general pests of sugar in the Indian sub-continent. In Malaya, *Proceras polychrysus* Meyr. is the worst pest of paddy, and much work on borer control in that country has been done by Pagden.

In India *Proceras* and the closely allied genus *Chilo* have recently been the subject of a valuable systematic study by Kapur on those species which are associated with sugar cane.

The life history of these borers is similar to that of *Diatraea* in the Americas. The resistance of the larvae to flood conditions in paddy fields, and their ability to migrate by floating from stem to stem recalls the opinion of Myers regarding the origin of the *Diatraeas*. After extensive investigations of borer parasites in wild host grasses in the Amazon basin, Myers concluded that *Diatraea* may well have originated in floating grasses of the genus *Paspalum*.

SCHOENOBIUS BIPUNCTIFER Wlk. (Pyralidae). The Yellow Stem Borer of Rice.

This species is also known as *S. incertellus* Wlk., and *S. punctellus*. It attacks rice only, and is a major pest throughout the rice growing areas of India, S. E. Asia, and the Southern parts of China and Japan.

There are several points in the life history of *Schoenobius* which distinguish it from other world borers. Eggs are laid in oval clusters of 50—100 on the underside of young paddy leaves. The clusters are covered with scales by the female moth. On hatching, the larvae may scarify the leaf epidermis but very soon bore into the stem.

Others drift away on silken threads to seek host plants, and in general the mortality at this stage is very high. The larvae soon kill the growing point of young rice, and a typical white tip appears on the leaves. Rapid tillering often masks the effect of this damage. In later attacks, the larvae in the topmost nodes cause a white abortive ear to emerge. Pupation is well adapted to the field conditions, and membranes are formed over the emergence hole so as to protect the pupa from the water. In dry fields, pupation may take place below soil level, and this has an important bearing on the control measures.

The complete life cycle may be the usual 36—40 days under tropical conditions, to over six months in Japan and North China. Each rice crop will normally receive two generations of larvae, one in the early transplant stage, and one in the early ear stage.

THE CONTROL OF STEM BORERS

The foregoing descriptions will have indicated the general similarity of all the species in their mode of attack. A perusal of the literature shows a marked similarity in the measures which have been proposed or adopted against borers in all parts of the world. It will be convenient here to consider control measures under the conventional headings, viz. cultural, biological and chemical.

Cultural Measures

It is trite, but necessary to state that the planter must seek the best variety, plant and cultivate it according to the best local practice. The judicious application of manures at the right time may also help to minimise the effects of insect attack. On the other hand, it has been observed frequently, especially with Noctuids, that the best grown plants are " drenched " with eggs, and so, even here, it is dangerous to generalise. The first requisite is a sound ecological study of the relation of the insects to the crop and wild host environments. Varietal resistance has so far proved insignificant, but it is quite practicable for an entomologist to make studies of borers in wild host sorghums and *Saccharums* in primitive areas such as New Guinea, which might bring to light certain desirable characters for breeding into existing graminaceous crops. The writer was about to make such a study on behalf of Mauritius on the outbreak of war in 1939, and to include a general parasite investigation. It is hoped that this work will be re-opened shortly.

The usual modifications of cultural practices, which the entomologist is from time to time bound to recommend to planters, are in the view of the writer of dubious general efficacy. The shifting of planting date to avoid a peak incidence of borers is excellent in theory, but in practice it demands routine biological observations on the part of persons quite unqualified to make them. A rule of thumb shift of date, on the other hand, deprives the planter of the exercise of the art of planting, for in the tropics there are few days in the season when a crop can be planted so as to give a maximum chance of success. The destruction of stubbles by up-rooting or ploughing is again good

theory, but those who have tried to struggle with the African clay soils in the baked conditions of harvest, can only regard these as text-book methods. Similarly, measures such as the trapping of moths, collecting eggs, cutting out deadhearts, burning canefields before cutting, have met with local circumscribed or merely alleged success. Let it not be thought that the writer is deriding plantation sanitation as an ideal to be sought constantly. Close seasons, and long fallows, so unpopular with European and local planters alike in tropical territories, have been of great benefit in the control of pink bollworm of cotton. But signal progress is more likely to be achieved in the two following spheres.

Biological Control

There are three aspects of control of borers by parasites or predators :—

(*a*) The encouragement of parasites already present by local breeding and release, or by improving the food plant situation.

(*b*) The importation of parasites of the same species of stem borer from other countries.

(*c*) The importation of parasites of allied *Pyralids* and *Noctuids* from cultivated or wild hosts abroad.

The first aspect is exemplified by the large amount of work on the minute egg parasite, *Trichogramma*, which is reared in batteries on the eggs of a stored products moth such as *Sitotroga* or *Corcyra*, and released amongst the crop at a critical time in the upswing of borer population. Tried in Louisiana, Barbados, India and Mauritius, the method has only become firmly established in practice in Barbados. There is unlikely to be any general extension in the future.

The encouragement of parasite food plants is an important subject which has received much attention in Mauritius. Bound up as it is with the more efficient control of weeds by chemical and other means, the provision of parasite habitats in cultivated ground deserves more detailed study.

The importation of foreign parasites is an attractive measure, involving much preliminary work of a high scientific order, as well as considerable personal organisation on the part of the entomologist. The voyages of Myers to the Amazon basin, and subsequent use of the Amazon fly, *Metagonistylum minense* Tns. in various West Indian islands against *Diatraea* is a classical example in this field. The Cuban fly *Lixophaga diatraeae* Tns. has been imported into Antigua with success, and into Barbados without result. More recently this fly has been sent to Mauritius for trial against the related Pyralid *Proceras sacchariphagus* Bojer. (spotted borer), since the parasites already present fail to give economic control. Already in 1939 the Mauritius Department of Agriculture had imported from Ceylon *Xanthopimpla stemmator*, a pupal parasite of the cane borer *Chilo zonellus*. This parasite became well established on its new host.

In continental areas, a highly adjusted parasite fauna exists, one or two dominant species from a list of a dozen or more Ichneumonids or Tachinids being commonly found in any one locality. It is always

questionable therefore whether further importations would in any way alter the balance. The Noctuid, *Busseola fusca*, in Africa is, for instance, almost immune from *Trichogramma*, but it is commonly attacked by *Apanteles sesamiae*, a Braconid, and *Zenilla evolans*, a Tachinid. In view of the great importance of this borer, ecological data on the whole parasite complex should be co-ordinated on a continental basis, so that the possibility of introducing species from other continents or islands can be explored systematically. A similar review of the parasites of *Schoenobius*, the Asian rice borer, might lead to profitable lines of parasite work.

Chemical Control

The field of chemical control of cereal pests is limited by the relatively low value of the crop and by its very nature as a native subsistence culture. The average area of tropical cereal fields is less than half an acre.

The use of a chemical dressing for young maize has been routine practice against *Busseola* for many years in South Africa, where 'Derrisol' derris suspension and latterly $2\frac{1}{2}$ per cent. DDT powder are tipped by hand into the plants at the "funnel" stage of growth. Successful control was obtained by Le Pelley in Kenya with 1 per cent. DDT, but the writer was unable to reproduce these results in Western Tanganyika in 1948, where final yields of maize were unaffected by the treatments. The method is, however, quite economic for small farms, and awaits the development of a cheap, persistent insecticide formulation, so that present objections such as precise timing and rain washing can be overcome.

The dusting of sugar cane with the ground mineral cryolite (sodium fluosilicate) has been practised locally in Louisiana against *Diatraea*, but it is not considered generally economic.

Sprays and dusts with a nicotine base have been used in experiments against the rice borers in Japan and elsewhere, but no serious attempt has been made to evolve a cheap formulation for the use of the small planter.

Preliminary experiments at the Silwood Park Laboratory of Imperial College of Science and Technology suggest that stem boring Dipterous larvae (frit fly) may be killed by parathion and the new systemic insecticides, but existing materials are not yet suitable, either in formulation or in price, for practical consideration. The necessity for an insecticide which is translocated within the plant is evident with most tropical cereal borers, where rapidly increasing new plant tissue is being exposed to oviposition by an invading insect.

Once again the plea is for planned critical studies of the exact way in which borers are affected by field treatments with chemicals, and for some co-ordination of the discordant results obtained under different agricultural conditions. When this is done, it may be possible to draw up a specification for an insecticide upon which developmental work may be done. In the meantime, it is hoped that the importance of the borer problem will be recognised, and that the idea of making common, even international cause, against it will bear fruit.

THE MODERN RANGE OF SEED DRESSINGS

By J. F. H. CRONSHEY, M.A.
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THE organo-mercury seed dressings were discussed in an earlier article. As was mentioned there, these materials were developed for the control of one single disease, bunt of wheat, caused by *Tilletia caries* or *T. foetida*. They proved, however, to be useful for several other seed-borne diseases, not only other smuts of cereals but foot rot and leaf stripe diseases of the same crops caused by fungi of quite different groups, *Fusarium* and *Pyrenophora* (*Helminthosporium*).

This naturally led to their being tried on a wide range of seed-borne diseases, among them the *Phoma Ascochyta* damping-off, stem rot and leaf spot diseases of beet, peas and *Brassicae*. Their use on these crops and on maize led to the interesting and novel observation that they also exerted a marked effect on damping-off diseases that were not seed-borne but soil-borne. The organo-mercury compounds can, I think, be considered the parents of all the new seed dressings because they introduced the idea of controlling soil-borne troubles by a seed treatment and started everyone testing miscellaneous chemicals as seed dressings. In fact they started the train of thought that led to the development of a laboratory (glasshouse) test against Damping-off as a standard 'screening' test for fungicides. Laboratories all over the world now use a simple test of this kind. Planted in heavily contaminated soil and held under conditions artificially maintained at levels very favourable for the development of disease, seedlings just do not appear at all from untreated seeds, and a chemical seed treatment that gives a good emergence may be considered promising for field trials.

The use of seedling Damping-off as a standard screening test has produced quite a large crop of seed dressings which, for the most part, are not particularly satisfactory against the seed-borne smuts but which are very much better than the mercurials when it comes to protecting the seed from the soil-borne *Pythiums*, *Fusariums* and even *Corticium* (*Rhizoctonia*) *solani*.

In view of the general activity of copper as a fungicide, it is not surprising that copper compounds have proved useful as protective seed dressings. They are not, however, so reliable as other materials that have been discovered and they are liable to cause damage to the young seedlings under some conditions. Zinc compounds have also proved useful but they are not very powerful and their range of usefulness is restricted.

The outstandingly successful materials have been three synthetic organic compounds, tetrachloroparabenzoquinone, sold under the proprietary name 'Spergon', 2,3-dichloro 1,4-naphthoquinone ('Phygon') and tetramethylthiuramdisulphide. All of these materials are remarkably good seed protectants and they are really in a class by themselves, with very little to choose between them. Tetrachloroparabenzoquinone is perhaps slightly less versatile than the other two; for example, it is almost useless against damping-off of beet by *Pythium*, though it controls the same disease quite well on peas—a quite extraordinary difference but one that can easily be demonstrated experimentally. Which is the best is probably governed by the balance of the soil organisms in each particular case. What is certain is that all three are very good.

Tetramethylthiuramdisulphide, TMTD for short, or thiram to give it its newly-coined name, is possibly the most versatile of the three and is the basis of several seed dressings; 'Arasan', 'Arasan' SF, 'Nomersan', 'Fernasan' and 'Premasan'. Literally thousands of experiments have been made with TMTD dressings and it would be very easy to list experimental data showing the very striking results that can be obtained. I think it is probably better, however, to present results from one recent laboratory experiment where the actual fungi associated with the damping-off were ascertained. This was a test on beet seed sown in contaminated soil in boxes in a greenhouse. The table is self-explanatory and it is unnecessary to describe the experiment in detail. It was, of course, properly replicated and the differences between the series are highly significant statistically.

BEET

Greenhouse Sowing in Contaminated Soil

	Plants from 120 seed clusters 9-1-51	Losses (3) 9—22-1-51	Plants (4) 22-1-51	Plants with (5) Hypocotyl lesions 22-1-51
No Dressing	78	33 (42%)	49	23 (48%)
Mercury (1)	157	73 (47%)	87	36 (41%)
TMTD (2)	168	6 (4%)	171	17 (10%)
	171	12 (7%)	164	18 (11%)
	156	11 (7%)	150	16 (11%)

(1) 1% Mercury Dressing used at 0.67%; *i.e.* normal mercurial dressing.
(2) Various formulations, but all equivalent to a load of 0.33% TMTD on seed.
(3) Inspection showed all these losses were due to *Pythium*.
(4) Including new seedlings emerged since 9-1-51 and with losses removed.
(5) 57% *Rhizoctonia*, 39% *Pythium*, 14% both.

These data, like many from other experiments, show the difference between mercury and TMTD. Emergence is nearly as good with mercury as with TMTD, but losses afterwards are another story. Incidentally the usefulness of TMTD against *Rhizoctonia* as well as *Pythium* is also demonstrated by these data. Control of *Rhizoctonia* is not complete, but seedling troubles caused by this fungus are greatly reduced.

Another intriguing outcome of screen-testing materials, under conditions more nearly approaching those in which they must work in the field, is the development of hexachlorobenzene for control of wheat bunt. This material is not appreciably different from the mercurial seed dressings in its practical performance against seed-borne bunt. The interesting points about it are that it is apparently specific against bunt, being quite useless even against other smuts, and that it only works on the seed in the soil; *i.e.* it is not markedly toxic on glass slides. It is reported to control soil-borne as well as seed-borne bunt. This last point is of practical importance only in a few places, but it is a notable technical advance.

Finally there is the advance of seed dressing into the entomological field. The spectacular control of wireworm damage in cereals given by only an ounce or so of gamma-BHC per acre and the success of even smaller quantities in some other crops are testimonials both to the outstanding efficiency of the insecticide and also to the value of putting the material in the place where it will have the most effect. The combination of insecticide with fungicide in a dual-purpose dressing ('Mergamma') may fairly be claimed as an advance comparable to the introduction of the mercurial seed dressing.

There has, though, been another dual-purpose dressing in use for some time, and this consists of only one material. Pure calomel can be applied to onion seed for control of onion fly and this same treatment gives an appreciable degree of control of white rot. This is a very much more cumbersome treatment than the 'Mergamma' type, because the amount of chemical required can only be put on to the seed with the aid of stickers. The seed has to be dressed with its own, or almost its own, weight of calomel. Still, the principle is the same and the treatment works. It was not developed as a dual-purpose dressing, but there is nothing new under the sun!

The 'Mergamma' principle has been extended to vegetable crops with the introduction of a TMTD gamma-BHC dressing ('Fernasan' B). For real success against fairly severe wireworm attacks, the range of use of such a dressing is limited to certain crops, owing to the difficulty of getting on enough material when the seed is a small one that is sown at a low rate per acre. Nevertheless, some effect may be expected and it is well worth giving this dressing a trial where wireworm is a minor problem in arable areas. Satisfactory results have been obtained in many cases.

In this connection, it is not out of place to compare such a treatment with the use of organo-mercury products on peas, sugar beet, and to some extent on barley and oats. It has been recognised for some time that the mercurials are useful in improving the 'stands' of sugar beet, peas and the cereals, and that they pay their way very handsomely. No one, however, expects them to be cure-alls and to prevent every failure and all damage. They are regarded as useful dressings, not miracles.

Now, because gamma-BHC is an expensive chemical, 'Mergamma' treatment of cereal crops and sugar beet is expensive compared with mercurial dressing; the man who has used it expects results every time and soon complains if he does not get them! But when a combined seed dressing like 'Fernasan' B is used on a vegetable crop that is drilled at under 10 lb. per acre, it is not expensive at all; certainly not in relation to the cost of the seed and the type of crop on which it is being used. Economics, therefore, should not prevent us from regarding it in the same way as mercurial dressing has been regarded in the past on the farm. Present data suggest that 'Fernasan' B may quite probably pay for itself on a wide range of non-cereal crops. It will probably give an economically useful result against the low population of wireworm constantly present in much arable land even where sowing rates are quite low.

It will be interesting to see how far this type of dressing develops in the next few years. Many more experiments are needed before its full scope—of pest or of crops—is properly known.

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TECHNICAL BREVITIES

This section includes information on plant protection problems in their widest sense, which has been obtained from reports received from our overseas representatives, to whom we have pleasure in making acknowledgement, and from published literature. Wherever the latter source has been employed, we have given the reference to the publication concerned.

INSECTICIDES

GRASSHOPPER PLAGUE

GRASSHOPPERS in plague proportions, which entered an area near Swan Hill, Australia, from points across the Murray River early in December, 1950, made destructive attacks on valuable pastures and on the lawns of the local bowling and lawn tennis clubs. Aerial spraying against the invaders with a benzene hexachloride mixture " E ", from two Dakota aircraft, which had resulted in a good " kill " of the grasshoppers in infested localities and prevented their spread to other areas, had proved the most effective method of combating the pests when they were swarming.

Melbourne Age, Australia, 5th December, 1950.

LOCUST CONTROL CAMPAIGN IN THE MIDDLE EAST

A three-year drive against a serious locust invasion threatening Africa and Asia was scheduled to start in Jidda, Saudi Arabia, in November, 1950, using BHC supplied mainly by I.C.I. The British Government, directing the campaign, will meet 97% of the cost, which will total $10 million.

Chem. Engng. News, 1950, 28 (43) : 3707.

COFFEE MEALY BUG (*Pseudococcus spp.*)

In Kenya, 'Agrocide' 3 applied at the rate of a dessertspoonful round the base of each coffee bush has shown a repellent action to the ants tending the coffee mealy bug. This encourages the reduction of mealy bug by predators. Re-application of 'Agrocide' 3 is necessary after rain. 'Agrocide' Dispersible Powder ($\frac{1}{4}$ lb.) mixed with DDT Wettable Powder ($\frac{3}{4}$ lb.) for painting coffee trunks gives immediate repellent action to attending ants. 'Agrocide' Dispersible Powder can also be used for treating the trunks from ground level upwards.

BLACK GRUB (*Epicauta spp.*)

This pest is controlled in the Argentine by 15—20 kilos per acre of a 10% BHC dust.

TINEID WHEAT LEAF-MINER (*Syringopais temperatella*)

Economic rates of application of 'Agrocide' products give good results against this pest in Cyprus. At sowing time 'Agrocide' 2 is applied at 50 lb. per acre, or in January 'Agrocide' 3 is applied at 42 lb. per acre.

BERSEEM CATERPILLAR (*Prodenia litura*)

In India 3 lb. 'Agrocide' Dispersible Powder per 100 gallons of water gave 100% kill of this pest.

WHITE ANTS IN LAWNS CONTROLLED WITH 'AGROCIDE' 2

'Agrocide' 2 provides a safe and simple method to control white ants in lawns. It can be most conveniently applied by mixing it with some damp sand or other inert filler and should be spread at the rate of 1 oz. of 'Agrocide' 2 per square yard. The lawn should then be well watered. It should be free of white ants for two or three months.

Veld, Cooper & Nephews, S. Af. (Pty) Ltd., Johannesburg, Summer Issue, 1950/51.

COLORADO BEETLE CONTROL: PARATHION AS OVICIDE

When eggs of the Colorado beetle (*Leptinotarsa decemlineata*) were treated with 0.1% of 70% parathion no larvae emerged. With 0.04% and 0.025% total emergence was 58% and 62% as against 68% in the control, and all the larvae were killed. The younger the eggs, the quicker was the kill. The larvae showed no inclination to eat and most of them died within 24 hours.

Schwartz, E. Anz. Schädlingsk, 1950, 23 (6): 87.

TURNIP SAWFLY CONTROL

In Germany DDT and lead and calcium arsenates were completely ineffective against turnip sawfly (*Athalia colibu*). From 70% to 80% kill was given by a 2% 'Viton' spray (15% BHC). Parathion as a 0.02% spray, or as a dust at 40 kg./ha., gave complete kills, but the usual concentrations of 0.01% and 20 kg./ha. were too low to give the quick and total larval kill essential in the field.

Warmbrunn, K., Anz. Schädlingsk, 1949, 22 (5): 72.

GREENBUG CONTROL: INTERNAL CHEMOTHERAPY BY PARATHION

In Oklahoma, U.S.A., excellent control of greenbug (*Toxoptera graminum*) was given by BHC dust (3% gamma isomer) at 12 lb./acre on winter oats. A 2% parathion dust was as effective. Preliminary

tests indicate that barley plants will translocate parathion from treated soil to the leaves in sufficient quantities to kill greenbugs for 5 to 6 weeks.

Annand, P.N., Rep. U. S. Bur. Ent. Pl. Quarant, 1949,1949 : 42.

SCALE INSECT CONTROL

In Zanzibar, laboratory tests were made against a *Saissetia* scale insect associated with Sudden Death disease of cloves by dipping infected twigs in insecticidal solutions. Complete kill of all stages was given by 7.5% ' Rentemul ' (thiocyanate) and good kill by 0.5% ' Pestox '. Azobenzene, parathion formulations, HETP and phenyl mercury, ' Fixtan ', were inferior, but ' Fosfern ' 20 (equals ' Fosferno ' 20) at 0.1% killed all eggs and nymphs.

Robb, R.I., E. Afr. Agric. J., 1950, 15 (4) : 227—8. .

INSECTICIDE TRANSLOCATION

It was established in New Jersey that DDT, DDD and parathion, sprayed or dusted on maize and pea crops, were not found in the cobs or shelled peas.

Ginsburg, J. M., 70*th Rep. N. J. Agric. Expt. Sta.*, 1949 : 114.

INSECTICIDE TOXICITY TO EARTHWORMS

In Germany it has been established that there is little danger of earthworm poisoning from DDT, BHC or parathion applied to the soil in insecticidal doses, although much higher applications than would be given in practice may have toxic or lethal effects.

Goffort, H., Anz. Schädlingsk, 1949, 22 (5) : 72—4.

SOIL POISONING BY ARSENIC : REMEDIAL TREATMENT

In Oregon soils containing as much as 1,600 lb./acre of lead arsenate spray residue in the top 8-in. were made productive for cereals by sulphur treatment and sweet clover cropping.

Ore. Agric. Expt. Sta. Bull., 477, 1950 : 72.

BENZENE HEXACHLORIDE AGAINST CANE GRUBS AND WIREWORMS

The outstanding result of experiment station work in Queensland during 1949 was the spectacular control of sugar cane grubs and wireworms by the use of benzene hexachloride. Over 7,000 acres were treated against grubs and 3,000 acres against wireworms.

150 lb. of 10% BHC dust on the plant crop gives complete protection from grubs over the plant, first ratoon and second ratoon crops, at a cost of less than £2. 10. 0. per acre per crop. An increase in yield of 20 tons of cane per acre was obtained in treated as compared with untreated plots. A dressing of 20 lb. of the same insecticide

per acre applied with the fertilizer at planting time gives complete control over wireworm as well. Fertilizer companies are mixing the insecticide with the fertilizer to the approved formula.

Report to 27th Annual Conference, Queensland Cane Growers' Association, March 7, 1950.

PARATHION TO CONTROL BAGWORM

In Ohio July and August spraying of bagworm (*Thyridopterix ephemeraeformis*) infested arbor-vitae trees (*Thuja occidentalis*) with parathion at the rate of 1 lb. per 100 gall. of water caused the death of all larvae on the sprayed trees, so that the bags could be pulled off and torn open with ease.

Polivka, J. B., J. Econ. Ent; 43 (1), 1950 (109).

Abstd. in Forestry Absts., Vol. 12, *No.* 1, *Sept.*, 1950, *Abst.* 770.

NEW METHODS IN THE FIGHT AGAINST THE COCKCHAFER

The use of an Aero-Mist-Sprayer affected a great saving compared with an ordinary motor sprayer in spraying fields and the edges of the forest with 'Hexalo' (BHC) for cockchafer control. The former delivers 100 to 400 litres per kilometre of forest edge compared with 2,000 to 6,000 litres used by the motor sprayer. It is, therefore, possible to use much higher concentrations and save on the cost of transporting spray.

Gemperli, L., Schweiz Z. Fortstw, 101 (4), 1950 (166—7), *Abstd. in Forestry Absts., Vol.* 12, *No.* 1. *September*, 1950, *Abst.* 757.

ELM TREE INSECT PESTS AND SPRAYING

Results of laboratory experiments at the Bartlett Tree Research Laboratories with various types of spray for the control of *Scolytus spp.* attacking Elm showed that the most successful were lead arsenate or wettable DDT.

Bromley, S. W., Sci. Tree Topics, 1 (10), 1949 (79—85).

Abstd. in Forestry Absts., Vol. 12, *No.* 1, *September*, 1950, *Abst.* 773.

'AGROCIDE' 2 ON LAWN GRASS

The timely application of 'Agrocide' 2 to the grass of the Rand Show Grounds (South Africa) eliminated a serious infestation of caterpillars which threatened to ruin the appearance of the grounds.

Veld, Vol. XIII: *No.* 14, 1950: *Cooper & Nephews, S. Af. (Pty) Ltd., Johannesburg.*

CAN DDT REPEL RABBITS ?

The Department of Agriculture, New South Wales, regards the following reports to be of considerable interest :—

(*a*) Golf greens treated with DDT to control black beetles and the club's ornamental shrubs treated with the same chemical seemed no longer subject to damage by rabbits.

(*b*) Passion vines, after being sprayed with DDT and Bordeaux mixture, were not troubled by rabbits.

Agric. Gaz., N.S.W., LXI : 9 : *Sept.*, 1950., *p.* 498.

CARROT APHIDS (APHIDIDAE)

Aphids which infest carrots, particularly those grown somewhat out of season, can be successfully controlled in New South Wales by a thorough application of DDT emulsion at a 0.1% concentration (4 fluid oz. of 20% DDT emulsion concentrate to 5 gallons of water), particular attention being paid to the undersides of the leaves.

Agric. Gaz. N.S.W., LXI : 9 : *Sept.*, 1950. : p. 473.

NOUVELLES ETUDES SUR LE PROBLEME DES TAUPINS EN BRETAGNE

The gravity of the problem of wireworms in Brittany, and notably in Le Finisterre, is confirmed. The infestations have a very local character depending on the cultural history of each field, which appears closely connected with the slight displacement of the adults, the bursting of the eggs and the development of the young larvae conditioned by the cultural factors proper to each soil.

The first relations established between the larval populations and the destruction caused on different plantations permit a forecast of the intensity of losses on any one cultivated crop by examining those which have taken place on the preceding crop. They can serve to establish, for each field, if it is necessary to undertake economically the application of chemicals.

At present a leading method of chemical control, which has proved its efficacy and is being rapidly generalised in Brittany on several thousands of hectares, while remaining to be perfected, is a disinfection of soils by BHC or its derivatives (S.P.C., T.T.C.) at a dose of 10 to 15 kilos of the product per hectare. The application can be made at the end of the summer or in the spring. Cultivation of potatoes should follow only two or three years after the treatment in order to prevent all action on the vegetative parts and the taste given to the tubers : the crop will be protected, thanks to the persistent insecticidal action of BHC in the soil. This persistence of action towards the larvae of *Agriotes* contributes to the spreading of the larvidical effects of BHC

treatments over a number of years. Nevertheless attempts are being made to improve the methods of control.

(*a*) by trying to obtain further knowledge of the insecticidal and phytocidal action of BHC over a long period.

(*b*) by experimenting with new insecticides.

(*c*) by seeking to group the adults or the larvae with the aid of attractive substances, which would be able to diminish the cost of treatments by reduction of the quantities of substances necessary to employ.

M. Rouband, Comptes Rendus Helodomadaires des Séances de L'Academie d'Agriculture de France, No. 14 : 11 *&* 18 *Oct.*, 1950, *pp.* 561—565.

WAR PLANES READY FOR INVASION OF LOCUSTS

A small force of sprayer and duster aircraft belonging to Chim Avir Ltd. is being held ready to repel a threatened invasion of Israel by swarms of locusts, preliminary test flights having been made to determine the capacity of the planes in spreading locust bait and dusting of insecticidal chemicals.

This force of planes will be reinforced by a Dakota of the Israel Air Force, in case of emergency.

Jerusalem Post, 12*th Feb.*, 1951.

FUNGICIDES

NEW FUNGICIDE

In Florida the copper salt of tetramethyl thiuram disulphide shows promise of being a good fungicide for use on potatoes, but needs further testing under severe blight conditions.

Ruehle, G. D., Rep. Fla. Agric. Expt. Sta., 1949., 1949 : 250.

SUNSCALD CONTROL

In New Jersey it has been shown that fungicides which control tomato foliage blight also control sunscald. Spraying against blights reduced sunscald on the fruit from 25% to only 6%.

Davis, B. H., 70*th Rep., N. J. Agric. Exp. Sta.*, 1949 : 28

CROP PROTECTION DURING PLUCKING

As a result of investigations by the Tea Research Institute into the exact nature and course of blister blight (*Exobasidium vexans*) of tea and its control in Ceylon—the following information has been elicited :—

The majority of infections take place through the upper surface of the leaf, making it possible to reduce the spray applications from 50 gallons and more per acre to the more economical output of 12—15 gallons.

'Perenox' at the concentration of 4 oz. in 10 gallons of water is recommended for the control of blister blight.

To reduce copper residues in manufactured tea to a minimum it is advisable to spray fields as soon as possible after plucking in order to allow the maximum number of days between a spray application and the subsequent pluck.

Experimental evidence points to the conclusion that spraying at intervals of between 7 and 14 days will give effective control of blister blight, so that a spraying interval of 9 to 10 days based on the usual estate practice of plucking on 9 day rounds should prove satisfactory.

In an experimental field a spectacular increase in yield was obtained over the severe blister blight period from May to October as a result of spraying with 'Perenox', which has shown a profit.

It is concluded that the principal benefit of spraying first year tea in plucking will result from the protection of the capital value of the bushes.

C. A. Loos, *The Tea Quarterly*, *Vol.* XXI : *Part* IV : *Dec.*, 1950, *pp.* 16—21.

SEED TREATMENT OF GROUNDNUT

In the U.S.A. results of six years' seed dressing trials on groundnuts in various states indicate that the main value of treatment lies in preventing seed rot between the time of planting and germination. Its value for control of seed-borne diseases is doubtful. The need for treatment is greater with machine-shelled seed than with hand-shelled seed. Response to seed dressing varied with climatic conditions.

Wilson, C., *Plant Dis. Reptr.*, 1950, 34 (4) ; 87—95.

PADDY FOOT ROT

In India effective control of paddy foot rot (*Gibberella fujikuroi*) was obtained by treating the seed with 'Agrosan' GN at the rate of 5 oz. per cwt. of seed.

BLISTER BLIGHT (*Exobasidium vexans*) OF TEA

In Ceylon a concentration of 4 oz. 'Perenox' per 10 gallons of water applied at the rate of 12—14 gallons per acre gives effective control. Low volume spraying is desirable to control 'run-off' and obtain quick drying of small droplets. A high degree of protection can be obtained by regular light spraying at 10-day intervals. The interval between spraying may be increased under favourable conditions. Spraying from bud break to the first tipping may require 12—15 applications if pruning is commenced about the end of June in the south west monsoon area.

Preliminary experiments on tea in bearing using copper dusts of the 'Perelan' type have shown promising results in South India.

Tea Quarterly, *Dec*. 1949. *Planters' Chronicle*, *Sept*. 1950.

MISCELLANEOUS

SNAIL CONTROL ON CITRUS FRUIT

In New South Wales snails move on to citrus trees in autumn and cause much damage to fruit. Even slight injuries pave the way for mould entry and much fruit spoilage results. Complete protection is given by spraying with Bordeaux mixture 2—2—80 or stronger before the fruit is attacked. Bordeaux residues are extremely repellent. The addition of 1 gall. oil to 80 gall. Bordeaux assists penetration, and a BHC emulsion enhances the value of the spray against the snails and controls Fuller's rose weevil (*Pantomorus godmani*).

Agric. Gaz. N.S.W., 1950, 61 (6) : 287.

WEEDKILLERS AND HORMONE PRODUCTS

STAR BURRWEED (*Acanthospermum hispidum*)

In Nigeria complete kill of this weed was obtained by applying 2 lb. per acre of 2,4-D sodium salt applied by high pressure sprayer.

ROOTING OF COFFEE CUTTINGS

In Nicaragua good results were obtained with ' Hortomone ' A on young cuttings, ½—1-in. in diameter from vertical wood. The length of each cutting was 18-ins. below ground and 9-ins. above, cut square at the ends. They were immersed 1-in. deep in 1 : 160 dilution of ' Hortomone ' A for 16—18 hours and planted firmly in the soil.

ONION SPROUT INHIBITION BY MALEIC HYDRAZIDE

S. A. Wittwer and R. C. Sharma of Michigan State College have found maleic hydrazide to be a good sprout inhibitor for onions. It is sprayed on the plants two weeks before harvest, when the tops are still green, at a dilution in water of 2,500 p.p.m. (0.2 pt. per 100 gall.) using 75 gall per acre.

Grower, 1950, 34 (10) : 455.

PROGRESS WITH GROWTH-PROMOTING SUBSTANCES

Florrigens is a name which has been given to the growth-promoting substances akin to hormones produced within plants which cause the necessary change of form from vegetative shoots and leaves to floral organs. A synthetic organic chemical such as α-naphthyl acetic acid, which has been found to possess similar capabilities, is being used in the West Indies to regulate the flowering of pineapple plants. Harvesting is simplified if all the plants in a field can be made to flower at the same time. Also, by counting the leaves before treatment, pineapples of a uniform weight can be obtained.

Another growth-promoting substance, ß-indolyl butyric acid, is being used in California to produce seedless figs without the necessity of cross-fertilization.

Supplement to the British Trade Journal & Export World— June, 1950.

Abstd. in "*The Planters' Chronicle*," *Vol.* XLV : *No.* 19 : *Oct.* 1, 1950, *p.* 517.

CONTROL OF WEEDS IN WATERWAYS BY 2,4-D

Approximately 500 acres of waterways in Louisiana were cleared of infestations of water hyacinth (*Eichornia crassipes* Solms.) and alligator weed (*Alternanthera philoxeroides* (Mast) Griseb) by applying 2,4-D at the rate of approximately 8 lb. per acre either by helicopter, by boat, or from the shore. Complete eradication was ensured by following up the initial spray with a second patrol maintenance spray.

Hitchcock, A. E. et al., Contributions from Boyce Thompson Inst., Vol. 16, *No.* 3, *pp.* 91—130, *July—Sept.*, 1950.

IMPORTANCE OF ARTIFICIAL HORMONES IN WEED CONTROL OF OIL-FLAX CULTIVATIONS

Oil flax is more resistant to artifical plant hormones than most weeds, though less so than graminous plants. Solutions of 0.5—1 kg. of 2M—4K (MCPA) in 100 1. water per ha. sprayed proved effective in eradicating 68—85% of the weeds without harming the flax. Solutions of 2,4-D Na salt used in the same way were also effective though not as good as 2M—4K. Average increase in seed yield with sprays was 317%, while dusting with preparations containing these hormones resulted in only 168% seed yield increase, though an average of twice as much hormone per ha. was used. A preparation containing the ethyl ester of 2,4-D proved too injurious to use on flax.

Otto Valle, Juhani Paatela, and Jaakko Mukula (*Agric. Res. Inst. Tikkurila, Finland*), *Maataloustieteellinen Aikakauskirja* 21, 89—108 (1949). (*English summary.*)

TCA—A PROMISING NEW WEEDICIDE FOR GRASS CONTROL

Extensive trials are planned in New South Wales in 1951 on TCA (trichloroacetic acid) of which there are two derivatives in use, the sodium TCA and ammonium TCA, for grass control.

Little is known of their toxicity to man or animals.

TCA is a contact, non-selective herbicide when sprayed on growing plants but, when applied to the soil surface, the chemical inhibits seedling growth of grasses more than broad-leaved plants. The period of soil sterility is relatively short, on growing grasses the killing action is very slow and the chemical is most effective when the soil is moist and light. Light rains following application are beneficial and there is evidence of some translocation of the chemical in deep-rooted grasses.

The TCA's are dissolved in water and applied as a spray at about 100 gallons per acre, either after top growth had been cut away, or to the standing plants (*e.g.* Johnson Grass) in the boot to bloom stage, or the soil after cultivation.

TCA seems useful for localised killing of grasses in crop and waste land, and for grass growth control, with small doses.

For the former purpose, 60 to 120 lb. TCA per acre are required, in each of two applications for some grasses, and 30 to 40 lb. per acre, and less, for grass seedlings and pre-emergence application respectively. For the latter purpose, 10 to 20 lb. TCA per acre, applied when the seed stalks appear, will often retard grass growth for a long period. Applied at ½ lb. of TCA per gallon of water, it can kill prickly pear. The main use for TCA in New South Wales seems to be as a substitute for sodium chlorate for grass control.

K. R. Green, B.Sc. Agric., Agric. Gaz. N.S.W., LXI, 9, *Sept.*, 1950, *pp.* 455—6.

IMPROVEMENT OF LAWNS — USE OF 'FERNOXONE'

'Fernoxone', applied at the rate of 1 oz. to 100 sq. yds. of lawn surface, destroys numerous broad-leaf weeds in lawns, especially in those containing the erect type of grass, without damaging the grasses. The product should be dissolved in sufficient water to cover evenly the area to be sprayed or watered. It can be applied with a knapsack sprayer, stirrup pump or watering can.

In lawns with prostrate types of grass, 'Fernoxone' may damage the grass to some extent, but this can be avoided by applying sulphate of ammonia at the rate of 30 lb. per 600 sq. yds. a fortnight before and, if necessary, again a fortnight after, treatment with the weed-killer.

Imp. Chem. Industries (Export) Ltd., Karachi, 1951.

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